



## **EPRI Long-Term Operations R&D Program**

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## **EPRI LTO Program Goals and Objectives**

- Technical basis for safe, reliable plant operation through extended lifetime
- Demonstrated technologies to support long-term plant management
- Research projects integrated with other EPRI programs
- External collaboration DOE, NRC Research, EDF, MAI, NEI, Owners Groups and IAEA



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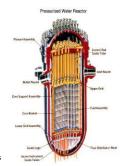
#### **R&D Focus Areas**

- Potentially Life Limiting
  - Primary system metals, welds and piping
  - Reactor pressure vessel
  - Electrical cables
  - Concrete and containment structures
- Opportunities for Modernization
- Advanced I&C
- On-line monitoring
- Advanced risks and PRA
- · Enabling technologies
  - Pilot plant projects and demonstrations
  - ILCM
  - Agin

Aging Management Programs		
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### **Priorities for 2013 - 2014**

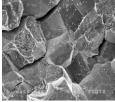
- Knowledge base of materials aging for 60 to 80 years
- · Plant demonstration projects:
  - Cable vulnerabilities
  - Containment inspections
  - Vessel internals inspections
  - Integrated Life Cycle Management software
- · Irradiated concrete testing program
- Produce Aging Management Programs (AMPs) gap report





### Materials R&D

- Close collaboration with existing Materials R&D Programs:
  - MRP, BWRVIP, PSCR
  - Collaboration with DOE LWRS
- · Projects to support LTO:
  - MDM revised for 60 80 years
  - Advanced welding for highly irradiated materials
  - RPV surveillance capsule projects for coordinated and supplemental data
  - Advanced radiation resistant materials (ARRM)
  - Materials property database for management of vessel integrity and internals
- Mechanistic understanding of SCC and IASCC



Example of IASCC of Irradiated Stainless Steel

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# **Cable Aging Management**

- EPRI Cable Aging Management Program Guidelines:
  - Medium Voltage Power Cables (1020805)
  - Low Voltage Power Cables (1020804)
  - Low Voltage I&C Cables (1021629)
- Projects to support LTO:

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- Collect historical in-plant radiation and temperature survey data
- Pilot walk down and survey guidelines to determine 'at risk' cables for LTO
- Push state-of-the-art technology for cable condition monitoring





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# Concrete and Containment Structure Aging Management

- Projects to support LTO:
- Pilot plant augmented containment inspections
- Long-term effects of irradiation and potential concrete damage
- SFP Leakage effects of boric acid on SFP integrity
- Toolbox to manage concrete aging



Funding	Completed Concrete Projects	EPRI No
TI Nucl Cond	Assessment of Needs for Concrete Research in the Energy Industry	1022373
	Nuclear Concrete Structures Aging Reference Manual	1023035
	Concrete Civil Infrastructure in United States Commercial Nuclear Power Plants	1020932
	Non destructive evaluation inspection of concrete structures subjected to corrosion	1025627
ITO Entertain	Effects of radiation in concrete	1025584
	Boric acid attack of concrete and reinforcing steel in PWR fuel handling buildings	1025166
ANT H	Embedded Sensors in Concrete	1023006
	Quality control of concrete during construction – Voids detection	1025300
NDE	Nonlinear Ultrasound to Evaluate the Integrity of Thermally Damaged Concrete	1026501
		RECIBIC POWER

Advance I&C and On-line Monitoring

- Close collaboration with EPRI I&C Program and DOE LWRS
- Centralized On-line Monitoring (COLM) publications
- Bruce Power Station (1024765)
- Ginna Tendon Monitoring (1025322)
- · Projects to support LTO:
  - Architecture to support advanced I&C structure
- On-line demonstration projects for EDGs at Sharron Harris and Generator Step-up transformer at Braidwood
- Develop automated diagnostics and remaining useful life applications

CC Tractor 10 Daving NAT/SHI

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# **Advanced Risks and Safety Analysis**

- Close collaboration with DOE LWRS on development of advanced risks assessment tools and techniques
- DOE development of RELAP-7
- Scope of work and benefits for LTO:
- Advanced thermal hydraulic tool for risk assessments
- Analysis the impacts of power uprates on plant margins
- Analysis the impacts of modifications on plant margin

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 Supports the SDP (Significance Determination Process)

0 CCP 2 HPI 2 PORV NO RCP TRIP				
0.6				
0.5				
8 0.4				
0 0.4 2 0.3				
0.2				
0.1				
0				
120% 120% 120% 120% 120% EPF EPORV EPF ERx				
EPORV				
Core Power & Enhancements				

Example RISMC Margin Recovery Results: 120% Power Uprate with Postulated Plant Enhancements

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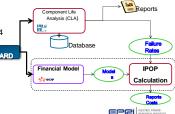
## Aging Management Program - Preparations for 60 to 80 Years of Operation

- Proactive review of Aging Management Programs (AMPs)
  - Adequacy and additional R&D needs for beyond 60 years of operation
- Reviews completed by EPRI and Industry SMEs
- Areas of identified gaps aligns with the MDM
  - Environmentally-assisted fatigue (EAF)
  - Reduction of facture toughness over time and radiation exposure
  - Need for mechanistic understanding of SCC and IASCC
- · Work with IAEA on International Generic Aging Lessons Learned (IGALL)

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## **Integrated Life Cycle Management Tool**

- Provide a methodology for effective decision making
- Three elements of the project
- Develop 'likelihood of failure curves'
- Determine optimal replacement or refurbishment strategy
- Create an Optimization tool platform
- Status
  - Beta version 2013
- Plant pilots 2013
- Technology transfer 2014



# Aging Management Programs for 60 to 80 years

- · Understanding of aging degradation
  - Mechanisms and failure modes
  - Initiation and growth rates
  - Detection of new degradation mechanisms
- · Inspection techniques
- Mitigation strategies
  - Repairs
  - Replacements
- · Condition monitoring
- Prediction of Remaining Useful Life



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2013 & 2014 Planned Deliverables	
Materials Knowledge Basis     Technical Update on Advanced Welding     Revision to Embrittlement Trend Curves     Containment Walkdown and Assessment GLs     Cable Aging – Temperature and Radiation Exposure	
<ul> <li>Cable Vulnerability Guidelines</li> <li>RISMC Case Study on Safety Margins in Power Uprate</li> <li>Pilot for Transformer and EDG On-line Monitoring</li> </ul>	
Advanced I&C – Structure for LTO     Life Cycle Mgmt (ILCM) Pilot Application and Software	
<ul> <li>Aging Management Programs Gap Analysis Review</li> <li>Demonstration of UT on Containment Liner Mock-ups</li> <li>Technologies for Refurbishment and Up-rate Decisions</li> </ul>	
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